C. W. SNYDER.

FOUR-CYCLE ENGINE.

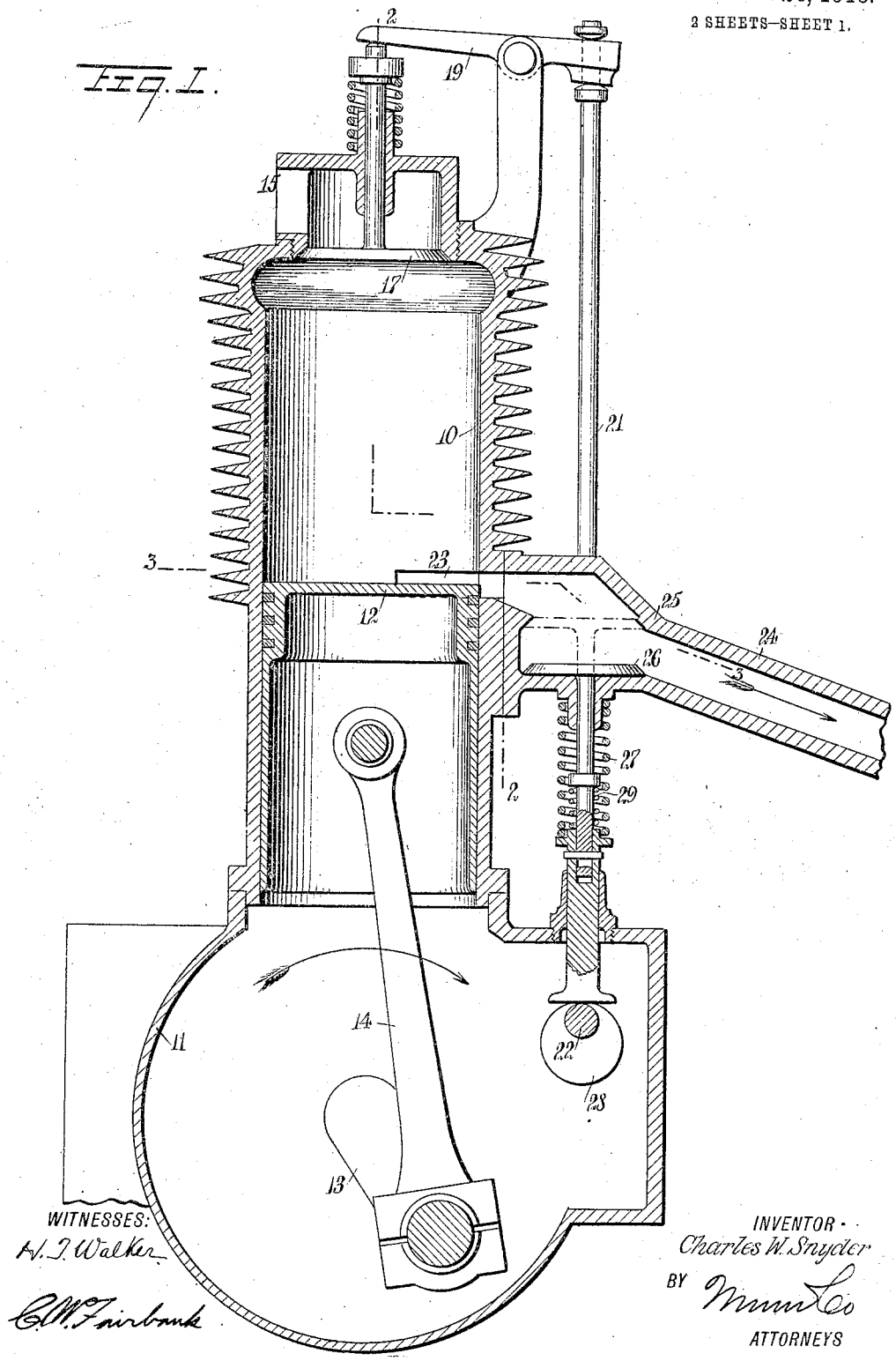
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1,126,309.

Patented Jan. 26, 1915.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 2.

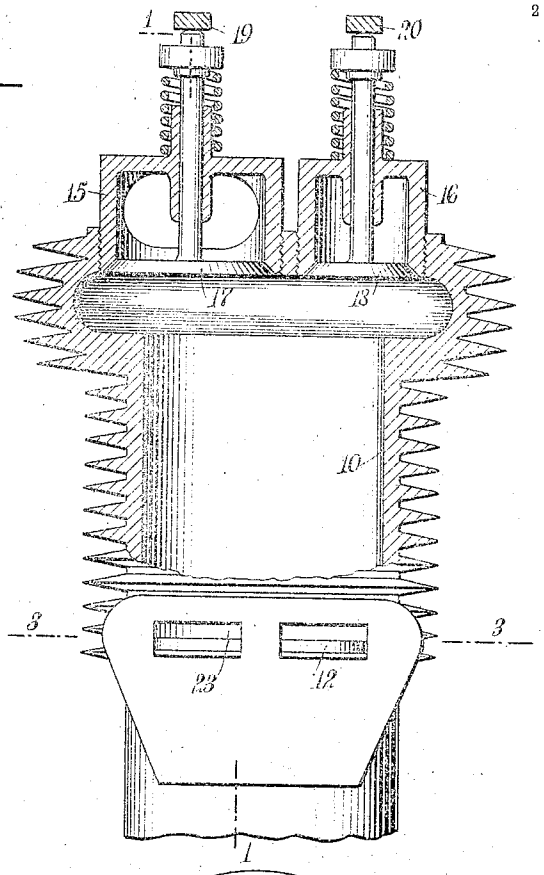
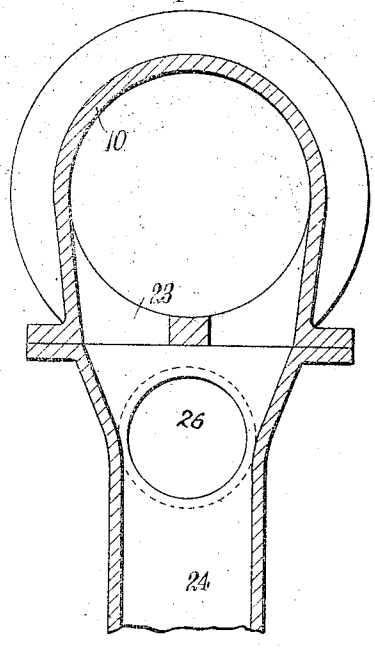


Fig. 3.



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FOUR-CYCLE ENGINE.

1,126,309. Specification of Letters Patent. Patented Jan. 26, 1915.

Application filed August 10, 1910. Serial No. 576,493.

To all whom it may concern:

Be it known that I, CHARLES W. SNYDER, a citizen of the United States, and a resident of Los Angeles, in the county of Los Angeles and State of California, have invented a new and Improved Four-Cycle Engine, of which the following is a full, clear, and exact description.

In four-cycle engines, it is customary, if not almost universal, to provide an exhaust valve, which is held open during the return stroke of the piston in order to force out the burned gases resulting from the explosion. In designing the engine, it is necessary to leave certain space between the cylinder head and piston in order to accommodate the explosive mixture while under compression, and prior to or at the time of the explosion. In the scavenging of the cylinder after the explosion stroke, this space is left filled with exhaust gas, which acts to dilute the fresh charge when the latter is admitted during the suction stroke following the exhaust stroke. In certain engines, an auxiliary exhaust port is provided which is uncovered by the piston when the latter is adjacent the end of its explosion stroke, so that some of the exhaust gas may escape in the same manner as the gases do from a two-cycle engine. The remaining gas is forced out by the piston on the return stroke, as above indicated.

The object of my invention is to secure not only the scavenging but also the cooling of the cylinder, by causing air to pass through the cylinder when the piston is at or adjacent the end of the power stroke, so that when the piston completes its scavenging stroke, the gases remaining in the cylinder will be largely air instead of burned gases.

I secure this object by so constructing the parts and so operating the valves, that the exhaust gas which escapes when the piston completes its power stroke, will by its own inertia or momentum, cause a partial vacuum in the cylinder and draw air into the cylinder through a second port.

Somewhat the same principle as applied to two-cycle engines, is disclosed in my prior Patent No. 918,211, issued April 13, 1909, and my prior application, Serial No. 522,573, filed October 14, 1909.

My invention does not reside primarily in the details of construction or in the positioning of the valves, inasmuch as these may be varied to a considerable extent without departing in any way from the spirit of my invention.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures, and in which—

Figure 1 is a longitudinal section through an engine constructed in accordance with my invention, a portion of said section being taken on the line 1—1 of Fig. 2; Fig. 2 is a longitudinal section taken on the line 2—2 of Fig. 1; and Fig. 3 is a transverse section on the line 3—3 of Fig. 2.

In the specific construction illustrated, I provide a cylinder 10, mounted on a suitable base 11, and having a piston 12, connected to a crank shaft 13 by a piston rod 14. The cylinder is provided with flanges whereby it may be air-cooled, although a water jacket may be provided, if desired. By means of my improved scavenging operation, the cylinder is cooled internally, so that the cooling of the exterior of the cylinder is more easily brought about.

In the cylinder head there are two valve cases 15 and 16, serving to support two inwardly-operating valves 17 and 18 of the puppet type. These valves are normally held closed by suitable springs, and at their outer ends may be engaged by rock levers 19 and 20, supported from the cylinder. The rock levers may be operated by rods 21, reciprocated by cams on a two-to-one shaft 22. The valves 17 and 18 serve as exhaust and inlet valves, the former communicating with the atmosphere and the latter connected to a manifold, a carbureter, or to any other suitable source of gas, fuel or explosive mixture, supply. There is no manifold or conduit connected with the valve case 15 of the valve 17, so that the outside air may freely reach the outer surface of said valve. The valve is illustrated as being larger than the inlet valve, although this is not positively essential to the proper operation of the engine.

The parts so far referred to in detail, are all old in the art, and, therefore, may be varied or replaced by equivalent parts also old in the art.

Adjacent the lower end of the cylinder, that is, adjacent the end toward which the piston moves during the power stroke, I provide the cylinder with an exhaust port

23, so designed that it is uncovered during the final movement of the piston in the same way as is the exhaust port of an ordinary two-cycle engine. This port is comparatively narrow, yet it is of such width that there may be a very free and rapid escape of gas from the cylinder when the port is uncovered. As indicated, the port extends around approximately one-half the circumferance of the cylinder. This port connects to an exhaust conduit 24, which is free and unobstructed, so that the gases may rush directly therethrough when the port 23 is uncovered. Within this conduit, is a valve seat 25 and a valve 26, but they are of such size and so disposed that when the valve is opened, they do not offer any resistance to the free escape of the gas. This valve is illustrated as being of the puppet type, and movable into engagement with one side of the valve casing. A spring 27 normally tends to hold the valve open, while the valve stem extends into the base and terminates adjacent the two-to-one shaft 22, upon which there is a cam 28 for operating the valve 26. Preferably, the valve stem is formed of two sections having lost motion connections, and an intermediate spring 29, whereby the valve may be resiliently held against its seat when the cam raises it to the position indicated in dotted lines in Fig. 1. The cam 28 is of such shape that the valve 26 will be completely opened when the port 23 is uncovered at the end of the power stroke, and will be completely closed when the port 23 is uncovered at the end of the suction stroke. The position of the valve between these two times is immaterial, as the port 23 is normally covered by the piston.

My improved engine operates substantially as follows: Assuming that an explosion has just taken place in the cylinder, the valves 17 and 18 will, of course, be closed and the piston will be moving downwardly on the power or explosion stroke. The piston eventually reaches the position indicated in Fig. 1, and uncovers the exhaust port 23. The valve 26 has previously opened to the maximum extent, and the exhaust gas under pressure in the cylinder, rushes out through the port 23 and the exhaust conduit 24. The gas is unobstructed in its flow, and the conduit 24 is of such length and of such size that when the pressure of the gas in the cylinder reaches substantially that of the outside atmosphere, the gas in the conduit continuing to move under its own inertia or momentum, will draw gas out of the cylinder through the port 23, so as to tend to create a partial vacuum in the cylinder. At the instant that the gas in the cylinder reaches atmospheric pressure or below, the large valve 17 is opened, so that the exhaust gases may continue to flow in the exhaust conduit under their own momentum, and air will be sucked in from the atmosphere past the valve 17 into the cylinder. If the valves be of the proper size and be properly timed, a large quantity of air will be drawn in in this manner, so as to completely or approximately completely, scavenge the cylinder and leave the latter filled with fresh and comparatively cool air. This cools the cylinder and piston internally, and reduces the amount of heat which it is necessary to remove by external cooling. The valve 17 is held open while the piston returns on what corresponds to the ordinary scavenging stroke, and the air which has been drawn into the cylinder past the valve 17 is forced outward again past the same valve. When the return stroke of the piston is completed, the space remaining in the cylinder will be filled with comparatively cool and comparatively pure air, instead of by hot exhaust gas. At or about the time the piston reaches dead center, the valve 17 is closed, and the valve 18 is opened, so that the piston may draw in the charge of gas or explosive mixture. The next three strokes, that is, the suction stroke, the compression stroke and the explosion or power stroke, are performed in the usual manner. When the piston reaches the end of the suction stroke, the valve 26 will be completely closed, so that if the pressure in the cylinder be slightly less than that of the outside atmosphere, no exhaust gas will be drawn back through the exhaust conduit 24. The valve 26 is useful primarily when the engine is throttled down, as the more the engine is throttled, the greater will be the partial vacuum in the cylinder during the suction stroke. It will be noted that the exhaust gas is permitted to escape as quickly as possible, so that it will have sufficient speed to get the momentum necessary to produce the vacuum, and it will also be noted that the valve 17 is made as large as convenient, so that the air inlet opening will be large and air may flow in freely.

By allowing the exhaust gas to escape almost instantly at or near the end of the power stroke, lessens the time that the hot gas is in contact with the cylinder walls, and, therefore, lessens the heat absorbed by these walls. The rush of the exhaust gas released through the port 23, produces a vacuum in the cylinder, which is relieved by the admission of outside air. Thus, the vacuum does not check the inertia of the exhaust, and there is no tendency of the exhaust gas to return into the cylinder. Furthermore, the inert gases are almost completely removed from the cylinder, so that as the new charge is mixed with atmospheric air rather than with the products of a previous combustion, a purer charge of greater mass may thus be inhausted into the cyinder during the suction stroke, and

greater power may be obtained from the engine.

In practice, with high speed automobile engines, the exhaust port 23 is uncovered by the piston or opened very rapidly by some other method, as a sleeve valve, when the piston is about 45 degrees from the end of the power stroke. In the type of engine shown, with an exhaust port cut well around the circumference of the cylinder, about 8 more degrees of angular advance of the crank shaft after the port 23 is first uncovered is required to clear the cylinder of the exhaust and to start the vacuum. In this particular type of construction, the vacuum is greatest when the piston has traveled about 25 degrees after uncovering the port 23, that is, when the piston is still 20 degrees before the end of the power stroke. A few degrees before the vacuum in the power cylinder is at its greatest, the secondary exhaust or air valve 17 is opened to allow the air to enter the cylinder. At 45 degrees past center, of course, the piston again covers the port 23 and all scavenging must cease. The scavenging must all be done at or near the end of the power stroke.

It is evident that the particular timing of the valves or port openings for securing the best scavenging results, must vary with the particular type of engine used and the method of controlling the ports.

The increase in power is obtained by having oxygen in the gas in the clearance spaces, which oxygen mixes with a slight excess of fuel in the charge drawn in from the carbureter. In the ordinary form of engine the gas clearance space is filled with exhaust gas at the time the charge is drawn in, so that the power of the explosion is controlled by the oxygen drawn in by the piston.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. An internal combustion engine having a working cylinder provided with ports for the exit of the exhaust, for the admission of air, and for the admission of the fuel charge, means for rapidly opening said exhaust port at any desirable point after the working piston has completed one half of its working stroke, and means for closing said exhaust port before the said piston has completed one half of the following stroke, means for opening a port connecting the interior of said cylinder with the normal air under normal atmospheric pressure at a time when a partial vacuum has been produced within the said cylinder by the inertia of the outrushing exhaust gas, and for closing the said port admitting air before the admission of any portion of the new charge.

2. A four-cycle internal combustion engine having two separate exhaust ports spaced apart, an exhaust conduit connected to one of said ports and the other of said ports opening freely to the atmosphere, and means for opening said last-mentioned port after the first-mentioned port has been opened and the pressure in the cylinder has dropped to or below that of the atmosphere, whereby air may be inducted through said last-mentioned port by the action of the exhaust gas, and may be exhausted through said port by the action of the piston.

3. A four-cycle internal combustion engine comprising a cylinder having a fuel inlet port and an exhaust port, means for opening the exhaust port at a suitable point in the engine cycle and holding the same open until the inertia or momentum of the gases escaping at a high velocity creates a partial vacuum in the cylinder, another port in the cylinder, said other port communicating with the outside atmosphere, and means for opening the said other port as soon as the said partial vacuum has been formed and holding the said other port open until the piston is about to start on its suction stroke, whereby the partial vacuum will draw air through said other port into the cylinder to dilute the remaining products of combustion, and whereby the products so diluted and the diluting air will be discharged by the piston through the port by which the air was admitted.

4. A four-cycle internal combustion engine comprising a cylinder having a fuel inlet port and an exhaust port, the said exhaust port located adjacent the end of the working stroke of the piston, a conduit connected thereto, means for opening the exhaust port when the working stroke is completed and holding the same open until the inertia or momentum of the gases escaping at a high velocity creates a partial vacuum in the cylinder, another port in the cylinder, said other port communicating with the outside atmosphere, and means for opening the said other port as soon as the said partial vacuum has been formed and holding the said other port open until the piston is about to start on its suction stroke, whereby the partial vacuum will draw air through said other port into the cylinder to dilute the remaining products of combustion, and whereby the products so diluted and the diluting air will be discharged by the piston through the port by which the air was admitted.

5. A four-cycle internal combustion engine comprising a cylinder having a fuel inlet port and an exhaust port, the said exhaust port located adjacent the end of the working stroke of the piston, a conduit connected thereto, means for opening the exhaust port when the working stroke is completed and holding the same open until the

inertia or momentum of the gases escaping at a high velocity creates a partial vacuum in the cylinder, another port in the cylinder spaced remote from the exhaust port, said other port communicating with the outside atmosphere, and means for opening the said other port as soon as the said partial vacuum has been formed and holding the said other port open until the piston is about to start on its suction stroke, whereby the partial vacuum will draw air through said other port into the cylinder to dilute the remaining products of combustion, and whereby the products so diluted and the diluting air will be discharged by the piston through the port by which the air was admitted.

6. An internal combustion engine comprising a cylinder having a fuel inlet port, a primary exhaust port with an exhaust conduit connected thereto, means for opening the said primary exhaust port before the completion of the working stroke, said port allowing the exhaust gases to escape at a high velocity until the momentum or inertia of said gases produces a partial vacuum within the cylinder, a secondary exhaust port opening to the atmosphere, means for opening said secondary exhaust port at the time the partial vacuum occurs within the cylinder, means for closing the primary exhaust port during the first half of the exhaust stroke, and means for closing the secondary exhaust port at or about the beginning of the suction stroke.

7. An internal combustion engine comprising a cylinder having a fuel inlet port, a primary exhaust port and a secondary exhaust port, means for opening the said primary exhaust port before the completion of the power stroke, so that the escaping gases acquire a high velocity and produce a partial vacuum within the cylinder, means for opening the secondary exhaust port at the time the vacuum occurs within the cylinder, and means for closing the primary exhaust port before the exhaust stroke has been half completed.

8. An internal combustion engine comprising a working cylinder and a working piston and having a fuel inlet port and a primary exhaust port, means for opening said primary exhaust port before the completion of the working stroke in such a manner that the escaping gases acquire a high velocity and by the momentum or inertia due to this velocity produce a partial vacuum within the cylinder, a secondary exhaust port, and means for opening said port at the time said vacuum occurs and before the end of the power stroke, said secondary port then communicating with the atmosphere, and the opening of said port allowing the air to enter the cylinder and relieve the vacuum, this air and any remaining products of combustion being ejected through this port on the exhaust stroke of the piston.

9. An internal combustion engine comprising a working cylinder and a working piston and having a fuel inlet port, an exhaust port with means for opening said exhaust port before the completion of the power stroke and for closing said port at or about the beginning of the exhaust stroke, a third or air port opening directly to the atmosphere, and means for opening said air port at or about the end of the power stroke and closing said air port at or about the completion of the exhaust stroke.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES WIGHT SNYDER.

Witnesses:
E. De Meulle,
A. M. McDermott.